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ABSTRACT

This paper, prepared by the New Jersey Science Teachers Association (NJSTA), presents the position that for education to be thorough and efficient, it must provide students with education in science. The paper is intended to provide an impetus for change in the laws of New Jersey relating to education. Topics discussed are: (1) Why teach science; and (2) Concerns of science educators relative to a science education program being brought about by state mandate. Thirty recommendations pertaining to all phases and participants in science education, from state to classroom levels, are presented. (SL)

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SCIENCE

CAN EDUCATION REALLY BE THOROUGH AND EFFICIENT WITHOUT IT?

A POSITION PAPER

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– SCIENCE –

Can Education Really Be Thorough and Efficient Without It?

A POSITION PAPER

The New Jersey Science Teachers Association takes the position that for education to be thorough and efficient it must provide students with education in the sciences.

The new challenges confronting science education nationally, and the imposition of "Thorough and Efficient" on education in New Jersey make it imperative that the New Jersey Science Teachers Association, a voluntary professional association of science teachers, set forth the essentials of a quality science program at all levels of the curriculum and the requirements for implementing such a program in the schools of New Jersey.

SCIENCE

Science is a dynamic, humanistic enterprise and that for education to be thorough and efficient such education must include science. Students must be taught the nature of the scientific enterprise: its basic assumptions, its philosophical structure, and the actions taken by scientists. Students must develop an understanding of the conceptual structure of science in conjunction with developing facility in the utilization of the processes with which scientists generate and verify new knowledge. These processes include observation, inference, measurement, and controlling variables. No science education can be thorough without students developing significant competency in the application of these scientific processes to their personal investigations.

Another component of a thorough and efficient education in science relates to the influences science has on present culture. These influences include personal qualities such as values, attitudes and appreciations, as well as broad philosophical impacts such as that caused by the evolutionary model in biology. Science teaching can not be thorough unless an integral component of any science course deals with the sociological, aesthetic, philosophical, political and economic impacts of science and its resultant technology upon society.

WHY TEACH SCIENCE?

Because science is a multi-faceted enterprise, the reasons for teaching it in schools are numerous. The development of critical thinking, one of education's most important basic skills, is a major goal of New Jersey's schools. Science's role among the disciplines is unique in that the provisions for students to observe, to manipulate and experience and to experiment are inherent in good science teaching. Science processes, an

integral part of science education, are basic to the concept of critical thinking: observation is a science process; differentiating between observations and inferences is important in science; learning to ask questions, to probe for and recognize appropriate answers is basic to science. Although diverse learning theories exist, they are consistent in their recommendations that abstract learnings are most efficiently taught if concrete, real-life examples are available for direct learner interaction. Science education is unique in that it must provide such concrete, real-life experiences.

Science education provides an awareness of, some control over, and a respect for one's physical environment. As students better understand the conceptual structure of science, they become more aware of the beauty and complexity of their surroundings and their interrelationships with their environment. With a better understanding of the conceptual structure of science comes the capacity for some degree of control over their environment. Knowledge of changes in the conceptual structure of science can lead to an understanding of the impact of science and technology upon our culture at both philosophical and practical levels. Copernican and Darwinian theories had dramatic philosophical impact. Contraception, plastics, innoculations, etc. have had effects, some might characterize as traumatic, which shaped our present culture. Such activities as genetic engineering and nuclear energy applications may lead to disaster or a better life. Students, with or without the necessary conceptual science structure to understand the ramifications of their actions, will soon make decisions on such issues as voters. Science education can improve the chances that such decisions will be rational.

Students benefit personally from science education. The psychomotor skills developed in laboratory activities may be used to solve personal problems and may also open career opportunities in the future. Science activities which are fun may stimulate further reading and provide applications for abstract mathematical concepts. Improved student teacher relationships are frequently established during periods of active science exploration. These are but a few of the many reasons why science education is a necessary part of a thorough and efficient education.

CONCERNS

In many cases science teachers throughout the state have been unable to facilitate the T & E process because they have not been provided with a comprehensive view of the process. In fact, different concepts of the process have arisen because of the imprecise and erratic transmission of the various stages of the T & E process through the education heirarchy.

Among the concerns of science educators relative to a thorough science education being brought about by the state mandate are several relating directly to the impact of T & E. Emphasis on the imposition of certain verbal and mathematical skills to the exclusion of science learning and skills poses a threat to the accomplishment of science instruction.

The overall change from the highly successful NSF model of program development in science curriculum to the mandated management systems model is felt to be a move in the wrong direction. The highly individualized and localized nature of science needs necessitate flexible programs and development not provided for under the management model. There is an apparent lack of concern for the format of science education in the entire T & E legislature.

The unique nature of science instruction, often dealing more with process than with content, raises the overall question and concern of evaluation and testing. In as much as there already exist many widely variable science instructional programs in many separate disciplines, it is difficult, at best, to imagine how uniform standards of accomplishment could be established without nullifying the very nature of science instruction, that being one of openness and applicability to individual resources and needs. In view of the impact a statewide testing program in science would have, it is the feeling of many science educators that the impetus provided by T & E towards assessment in science be directed to the local level and situation.

Other concerns of science educators presently center around indirect influences of T & E on science education. These include the loss of personnel at all levels of the educational process which in fact only serve to compound the aforementioned concerns. In addition, the trend toward the establishment of interdisciplinary programs excluding the involvement of science personnel from the planning and instructional stages may result in the loss of direct learning of the concepts and skills best instructed through the avenues of the science process.

RECOMMENDATIONS

The recommendations that follow reflect some of the particular concerns of New Jersey science educators.

The State should:

- -Provide consultant assistance with specific competencies in science education.
- -Provide updated and expanded regional science services and resources.
- -Mandate adequate science instruction time for all pupils K through 8, consistent with T & E.
- -Mandate a minimum of two years of laboratory science in grades 9 through 12.
- -Provide funding of local innovative and interdisciplinary programs including salary provisions for personnel involved.

-Re-examine certification requirements and mandate levels of science preparation commensurate with modern science instruction and a thorough and efficient education.

-Examine the present legal interpretations and policies which restrict or impede the learning process.

-Investigate the facilitation of bulk purchase of science materials on an interdistrict basis.

-Provide a clearer transmission of the state mandated T & E process which should be presented jointly to teachers and administrators in each local district.

Teacher Certification Programs should:

-Provide specialized content and methods courses consistent with activity oriented science programs.

-Employ methods and activities in teacher preparation courses that are similar to those which will be used in the classroom and should emphasize the function of the teacher as a facilitator of learning.

Professional Organizations should:

-Provide leadership in workshops, inservice work and materials production.

-Encourage text book publishers to incorporate science content into their reading and math programs.

Local School Districts should provide:

-Articulation K through 12 that is consistent with developmental theory.

-A commitment to continuing inservice development by providing time, resources and compensation.

-Class size appropriate for each type of science activity.

-Suitable materials and facilities for hands-on science activities.

-A basic exposure to biological, physical and earth sciences as well as the problems of our society on which science can have an impact.

-Opportunities for teachers to explore interdisciplinary cooperation between the sciences and other subject areas.

-Adequate financing and resources necessary for thorough science education.

-Sufficient support personnel for the teacher consonant with the unique nature of science instruction.

-Policies for the hiring of teachers that are consistent with the science program of the district.

-An organizational structure, especially at the elementary level, that will provide personnel for the efficient implementation of science instruction.

-For the development and assessment of science curricula at the local level.

Board members should be cognizant of the fact that a thorough education must include science education.

The Staff:

-Should provide increasing emphasis on science related careers as technological developments cause occupational and employment opportunities and changes.

-Should incorporate inquiry experiences at each grade level of science instruction.

Supervisors should develop a supportive atmosphere aimed at the improvement of instruction.

Administrators and teachers should be cognizant of the fact that a thorough education must include science education.

Science teachers should engage in an ongoing program of educational development leading to increased competencies in science.

SUMMARY

Instruction at any level must be responsive to the nature of the subject being taught and to the nature of the learner involved. Earlier in this paper the multi-faceted characteristics of the scientific enterprise were partially described. The complex nature of learners is well known to science teachers as an array of differing attitudes, interests, and abilities. These factors combine to make science education a challenging field. To this challenge has been added the goal of individualizing instruction, through media and materials usage, to maximize the scientific literacy and the career potential of each science student.

Obviously, science education shares its problems and goals with other fields of instruction. However, two characteristics of the scientific enterprise differentiate science instruction (both philosophically and practically) from other fields. They are: (1) the concepts of science that are presently accepted and (2) the processes of science that have been found useful in developing new knowledge and solving problems in areas amenable to empirical methods.

It is the latter characteristic that has a profound effect on the role of science teachers. Science instruction, to be effective, must be activity and/or laboratory oriented. The processes must be practiced. Reading about science has use, but it should not characterize the science program. To provide a comprehensive environment for process learning, materials and the time to prepare them must be available. This includes the freedom to bring things to the classroom and to take students outside the school. It also necessitates that the teacher is secure enough in background and support not to have to know the answers to all the questions a successful lesson should generate.

The "hands-on" approach, combined with individualizing techniques, applied to a conceptually based subject, makes science a unique area of instruction As with instruction, curriculum development and assessment procedures must also be responsive to the nature of different fields.

The Association hopes that this position paper will serve as a guide for the establishment of local goals, objectives, and policies to insure a thorough and efficient science education for the youth of New Jersey. This document should also provide impetus for changes in the laws of the State of New Jersey related to education (Title 18A) and the policies of the State Department of Education toward meeting the proposed recommendations.